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Kobayashi et al.

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(54) **SWITCH CASE WITH PARTITIONED PASSAGES**

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H01H 9/02 (2006.01)

(52) **U.S. Cl.**
USPC **200/306**

(58) **Field of Classification Search**
USPC 200/306, 302.1
IPC H01H 9/346,9/04, 9/047, 13/06, 19/06, H01H 21/08, 23/06, 85/0021, 2009/04, 2013/06
See application file for complete search history.

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(57) **ABSTRACT**

A switch designed for dustproof performance by minimizing a route of entry of dust from a terminal portion, includes a plurality of terminals, a movable contact piece that is supported in a manner allowing displacement between a non-conduction position and a conduction position, and a contact actuating member that displaces the movable contact piece in response to an externally applied pressing force. A main body of the switch includes an opening communicating with the outside, partition walls formed between the opening and the movable contact piece, barrier walls formed between the opening and the movable contact piece, and passages formed by ends of the barrier walls and walls that are opposite the ends of the barrier walls. Each partition wall extends across the corresponding passage and each terminal includes a connection portion and a blocking portion that is bent from the connection portion and blocks the corresponding passage.

4 Claims, 9 Drawing Sheets

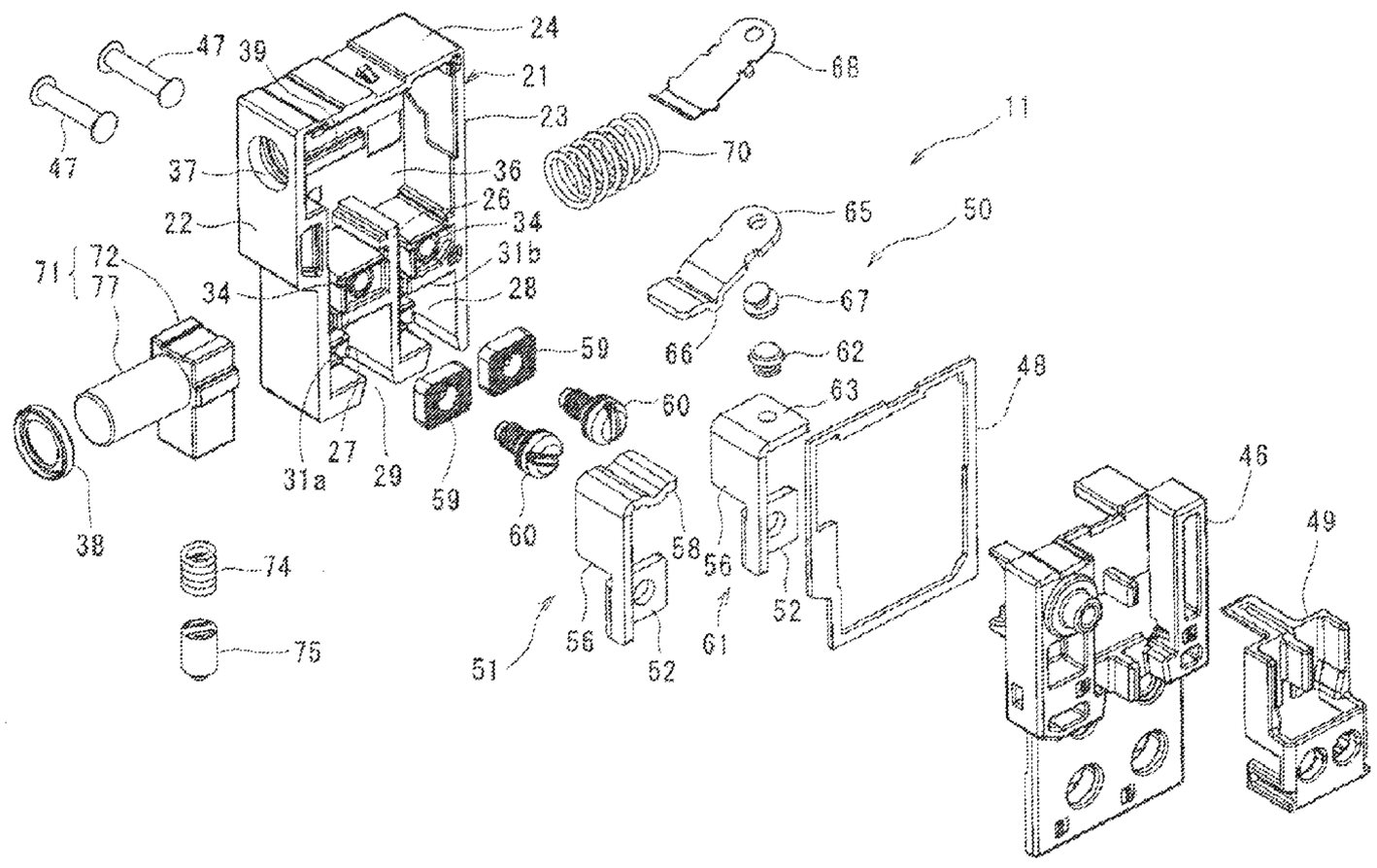


FIG. 1

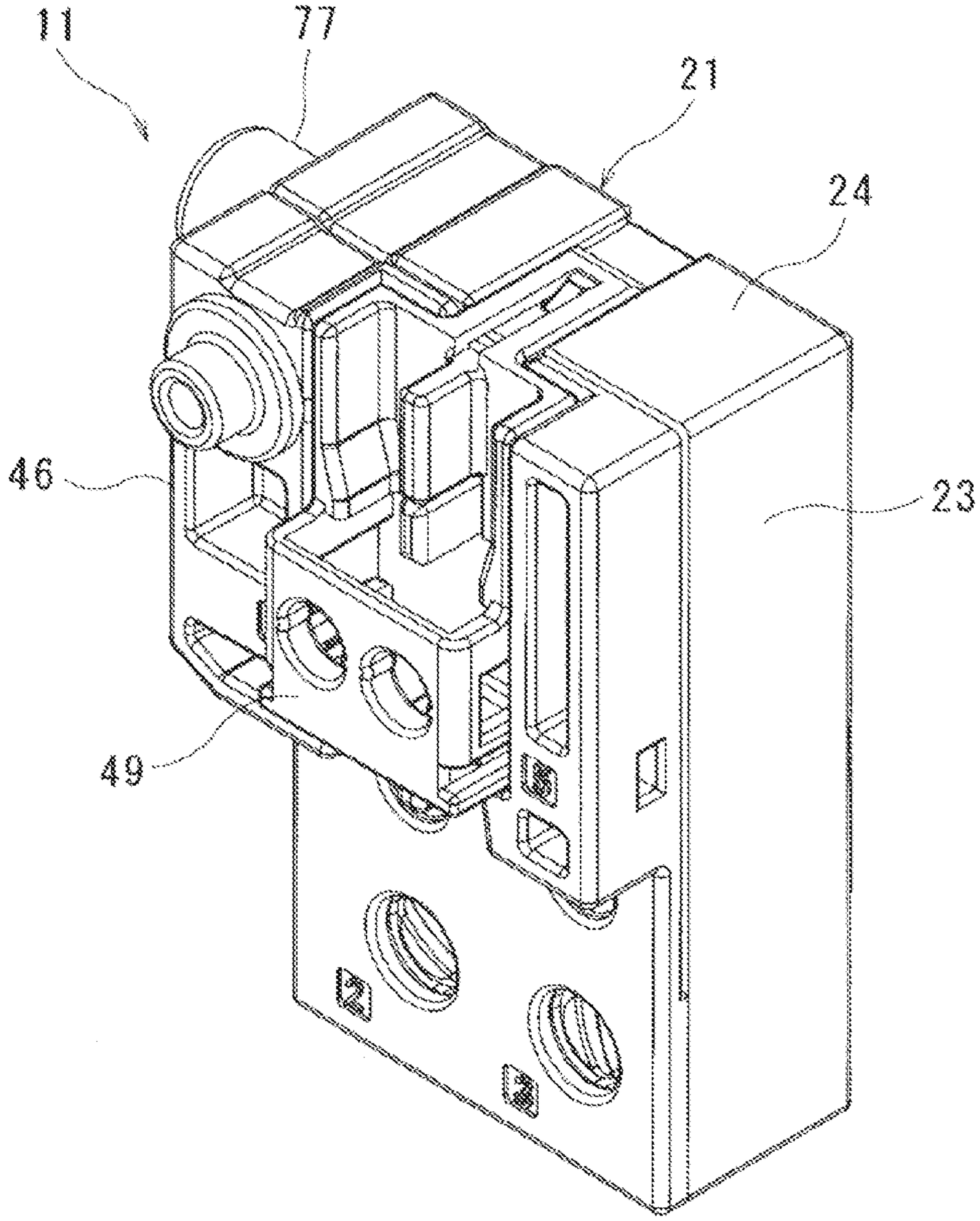
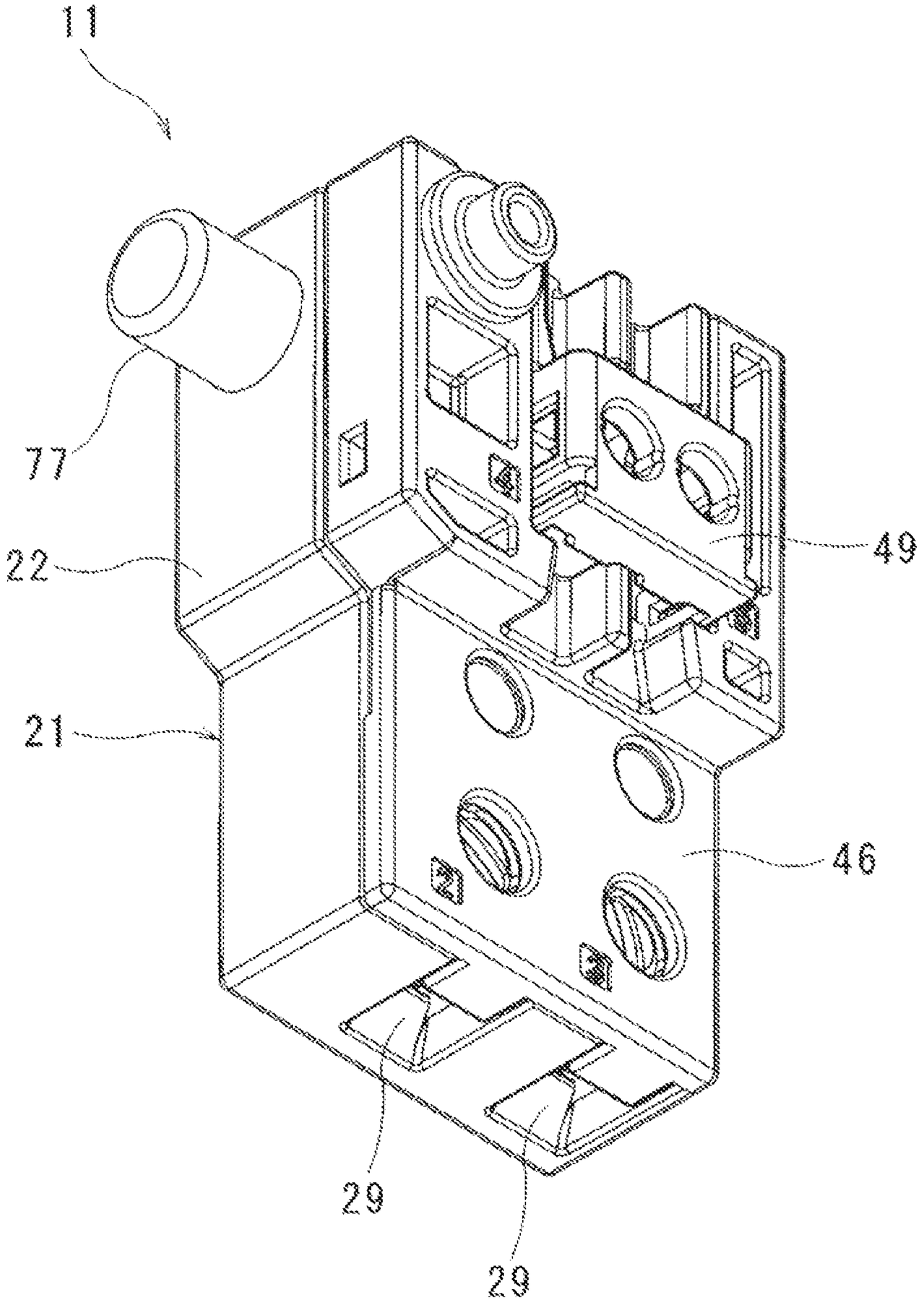
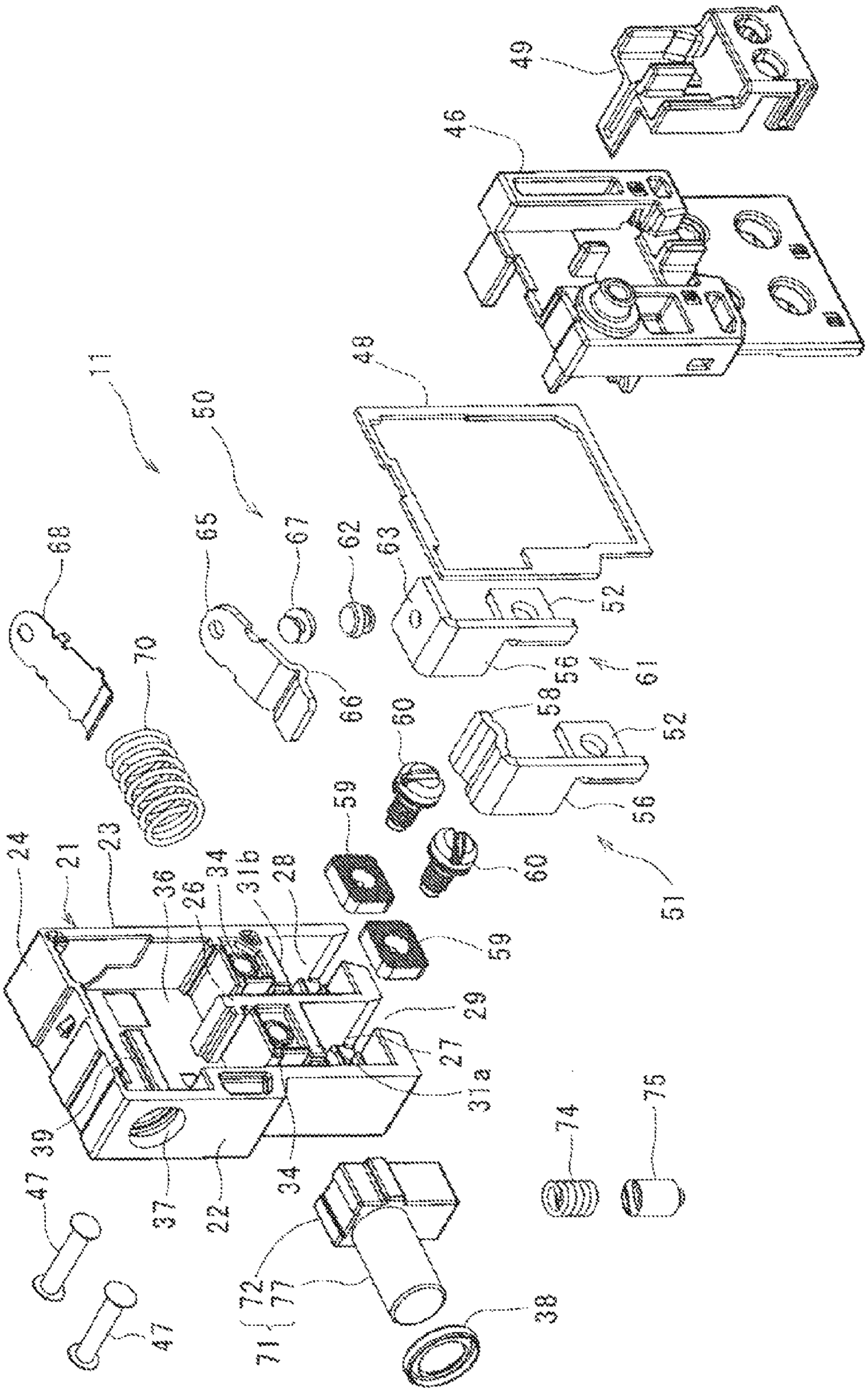


FIG. 2

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31b
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FIG. 3

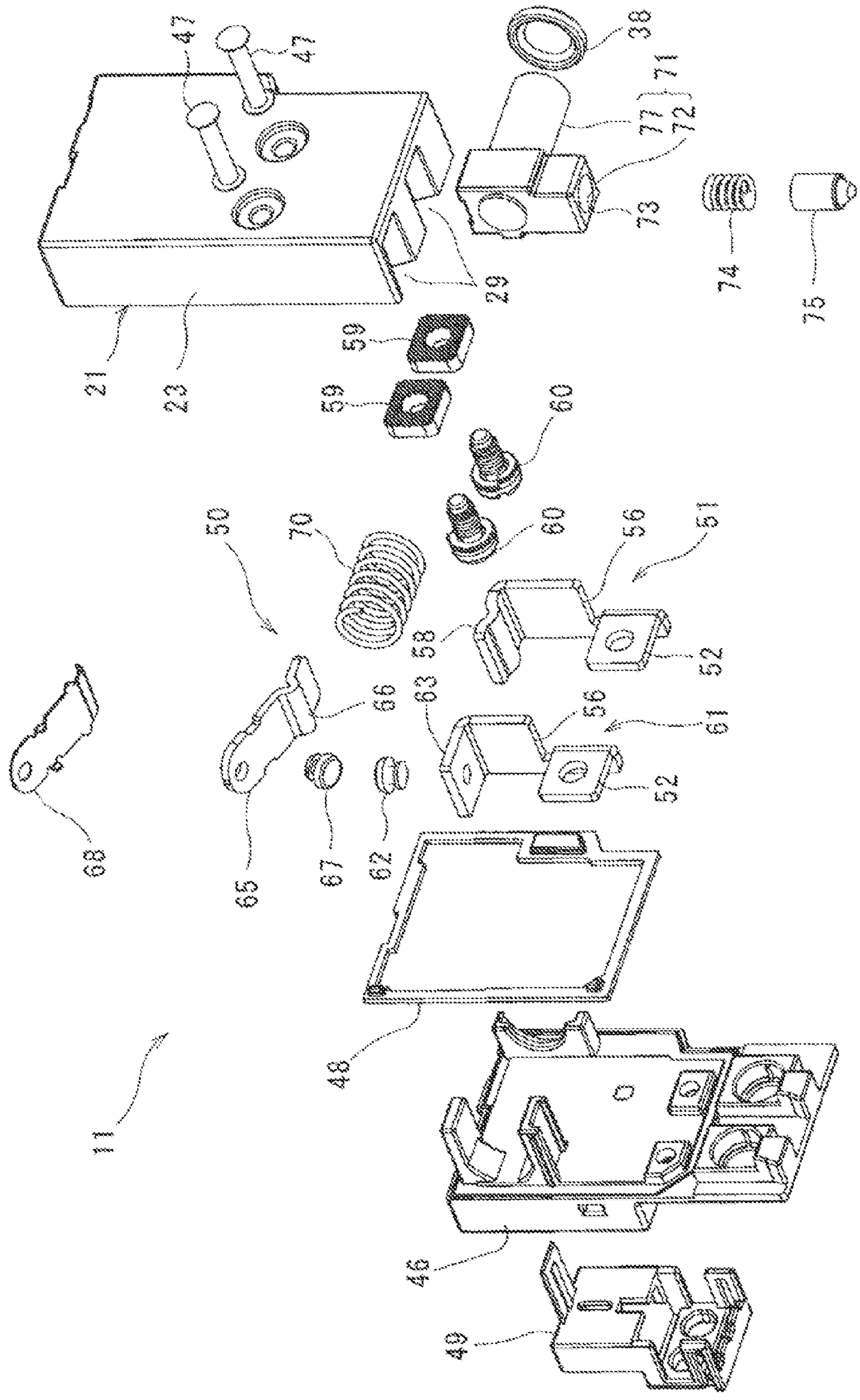
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FIG. 4

FIG. 5

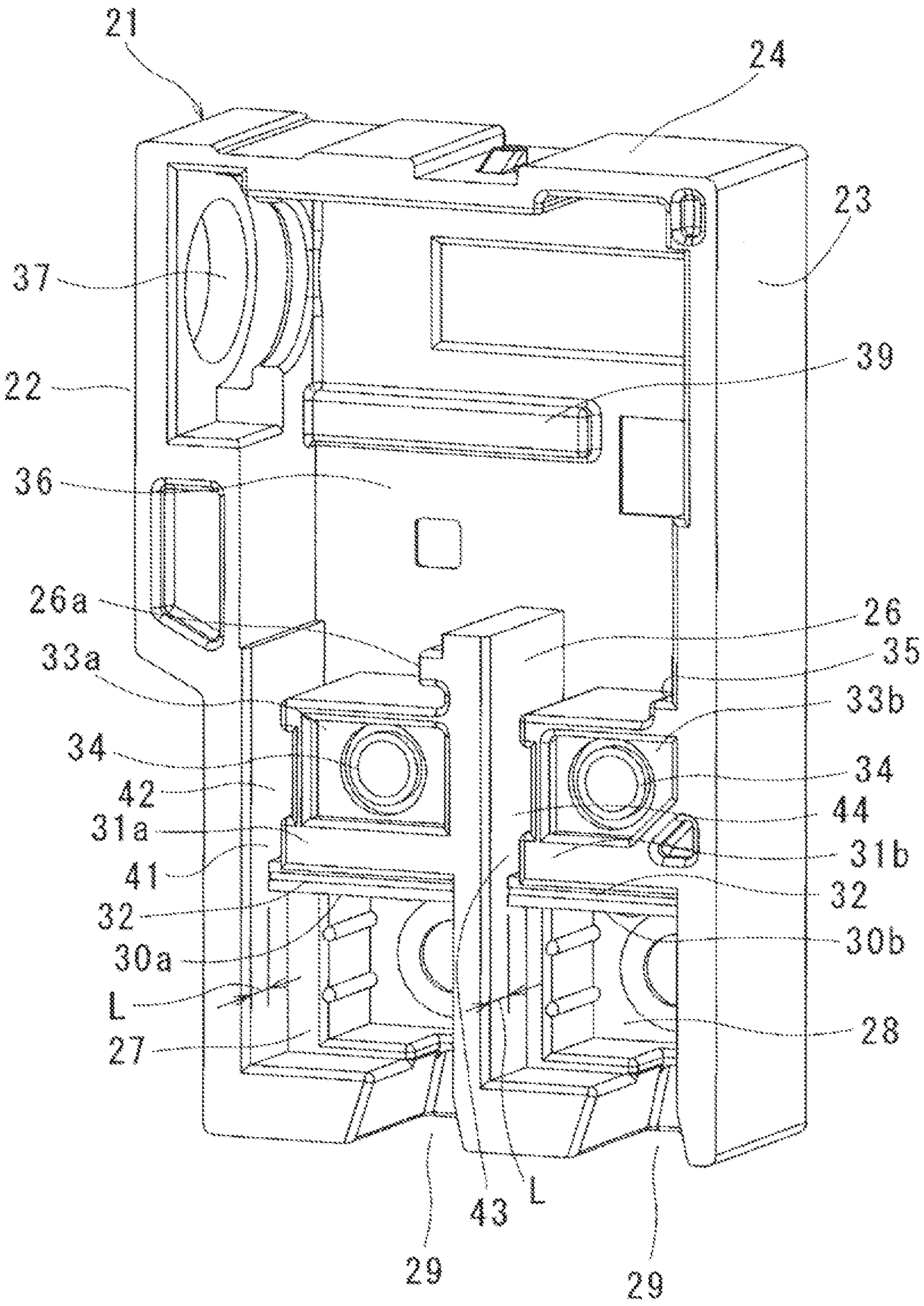
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FIG. 6

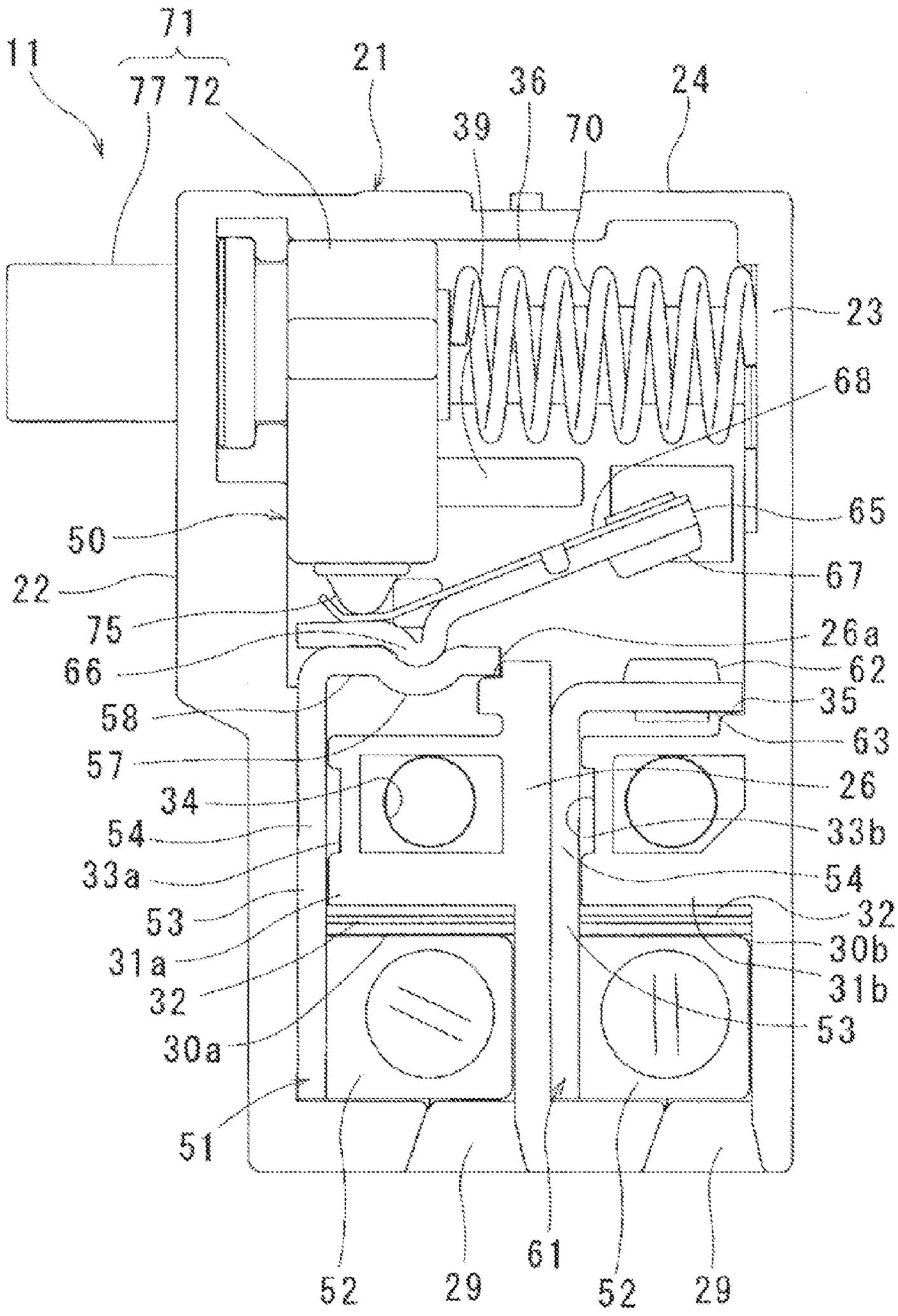
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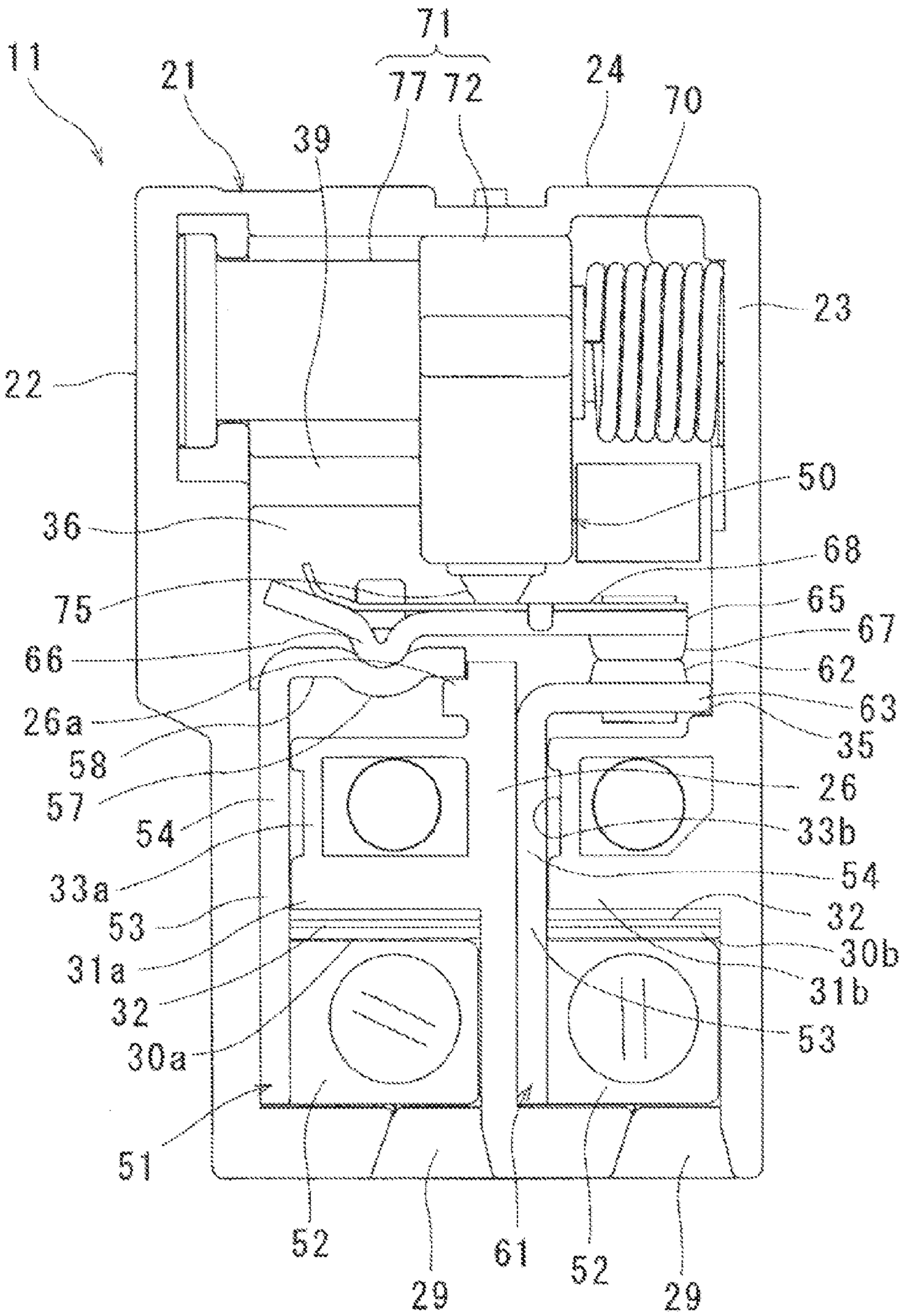
FIG. 7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33b
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FIG. 8A

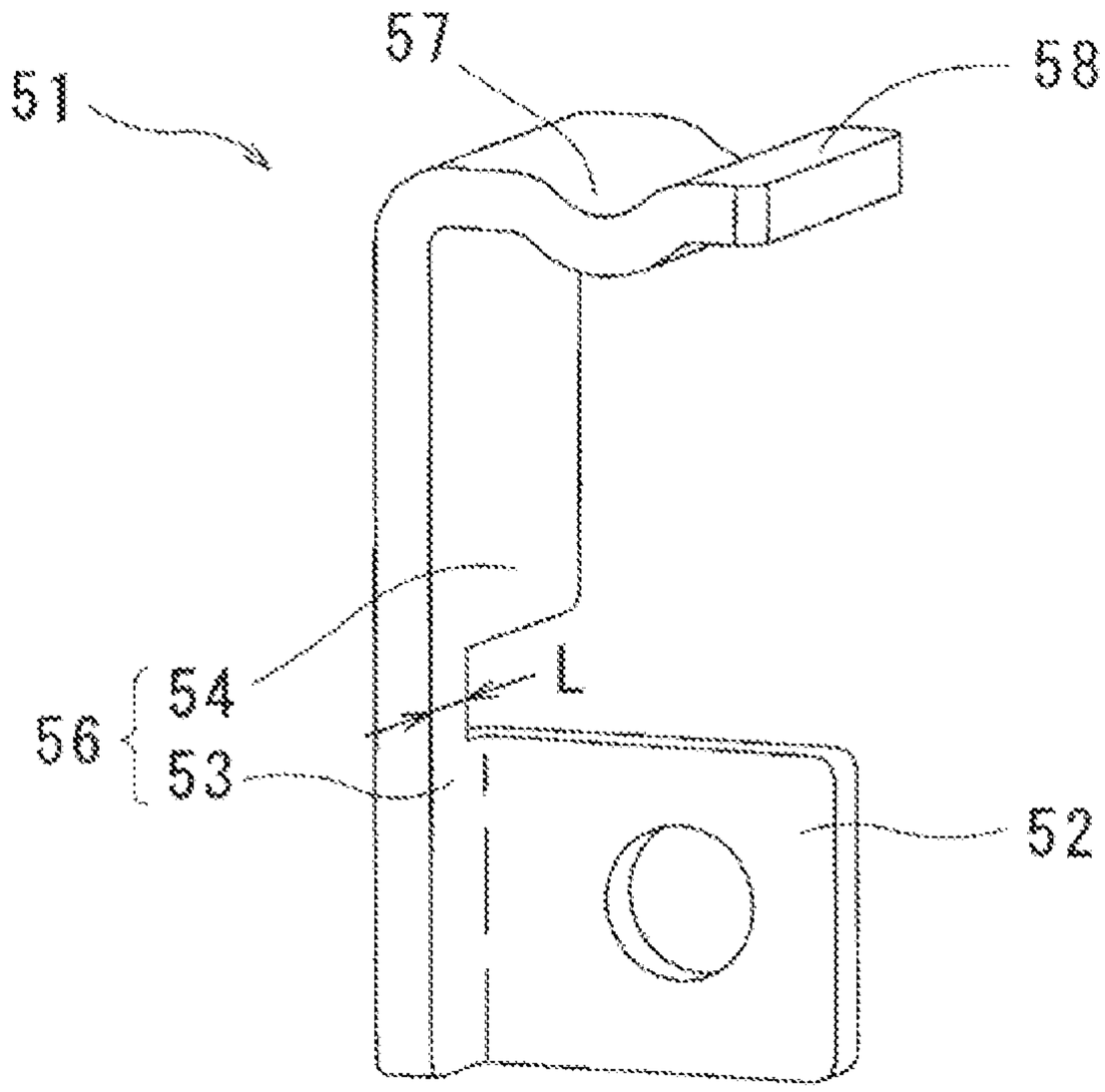


FIG. 8B

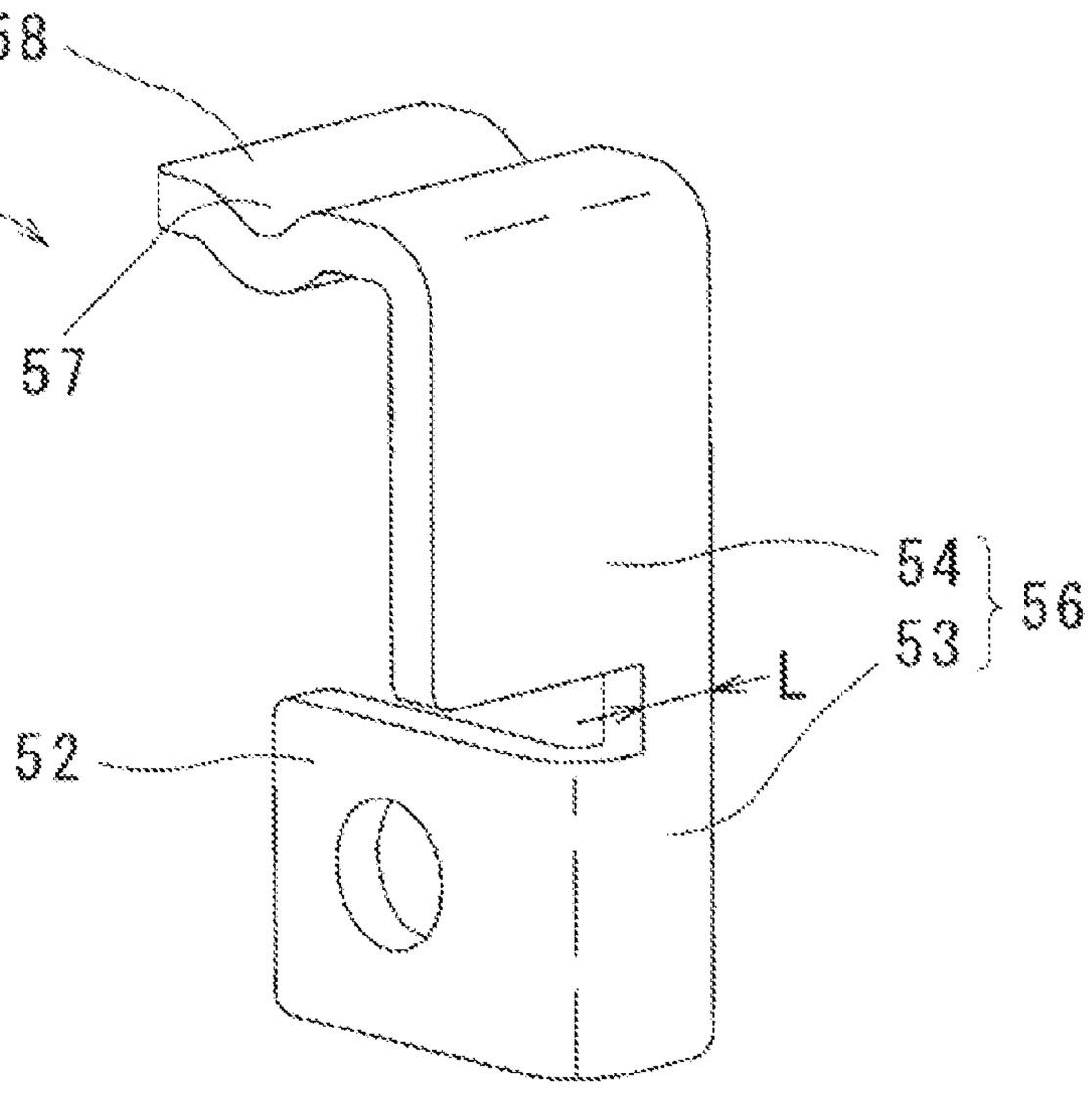


FIG. 9A

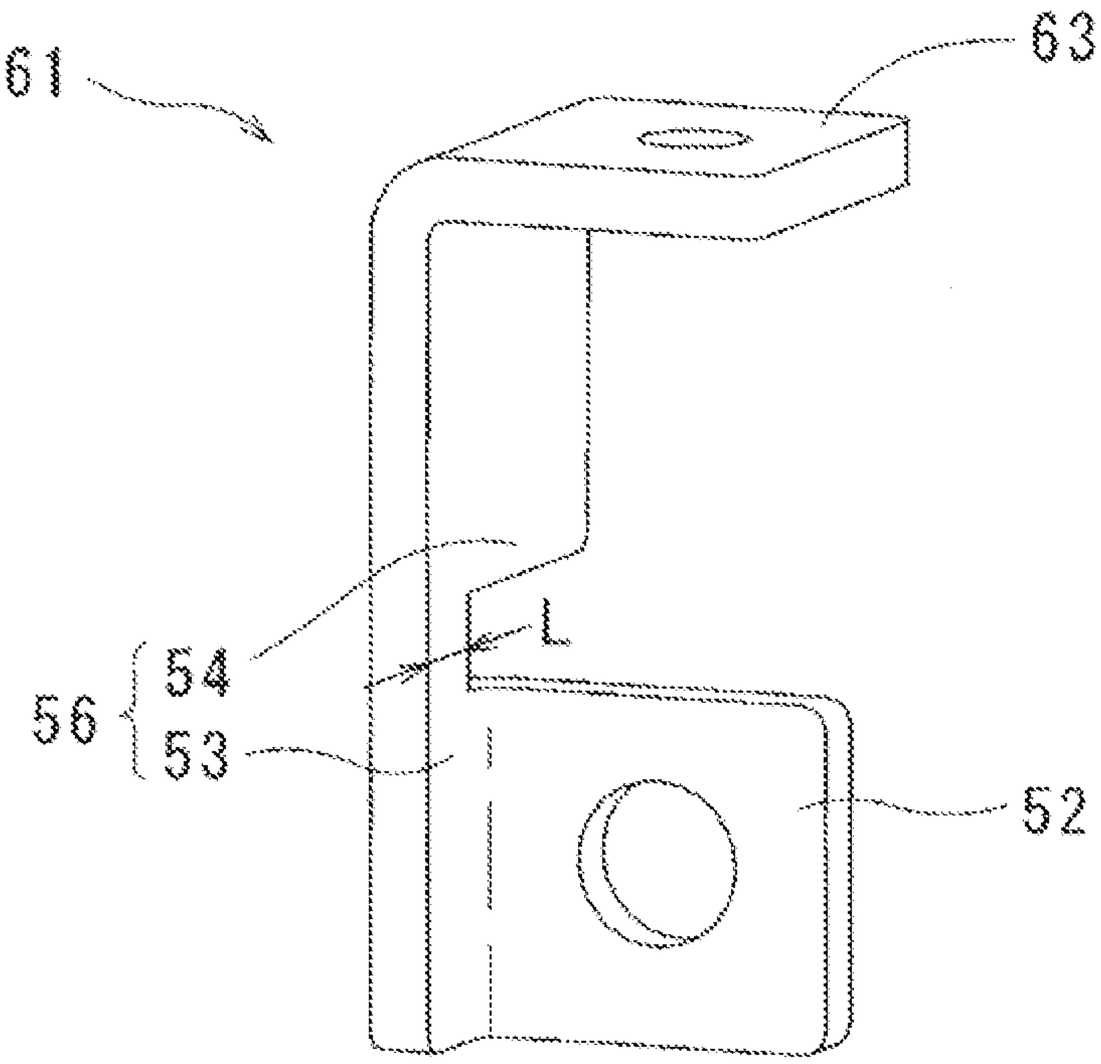
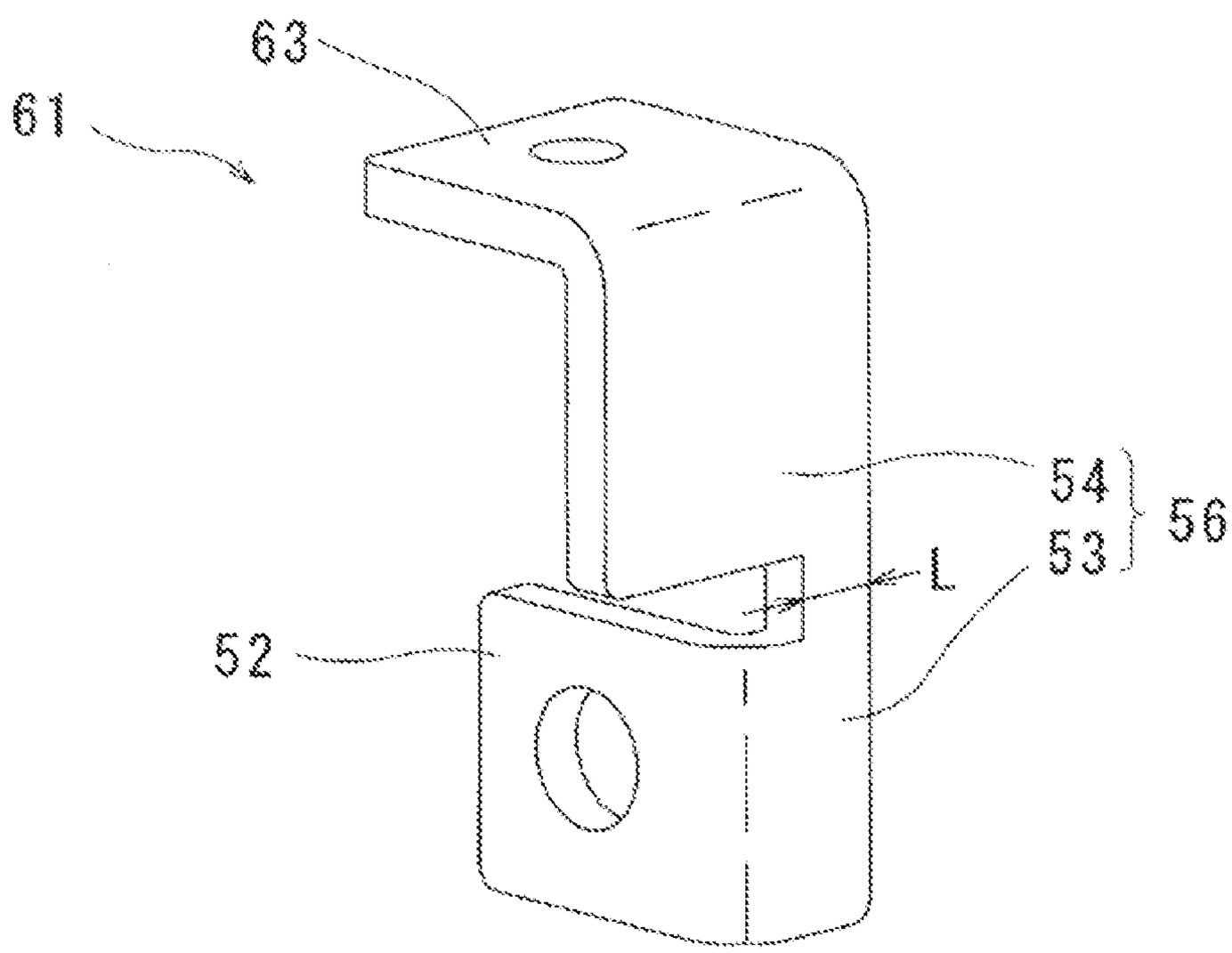


FIG. 9B



SWITCH CASE WITH PARTITIONED PASSAGES

BACKGROUND OF THE INVENTION

1. Technical Field

The present invention relates to a switch which is installed in a grip of power tool or the like and can start the power tool when a user pulls in the switch with the fingers.

2. Related Art

Conventionally, in order to prevent dust from entering the inside of a switch from a terminal hole, various methods are proposed including a method in which terminals are insert-molded in a housing of the switch, and a large amount of grease is spread between the terminal and the housing, and the like.

For instance, Japanese Patent Application Laid-Open No. 2005-93347 discloses a switch which prevents dust from entering the inside of a main body thereof by employing a structure in which a fixed contact thereof is insert-molded.

However, this switch is disadvantageous in that the manufacturing cost is increased due to the insert molding. Moreover, the method of spreading a large amount of grease is also likely to be disadvantageous because the production cost increases due to an increase in the number of manufacturing processes and operation failures which occur due to the grease adhering to the contacts inside the housing.

The present invention has been made to alleviate the above-mentioned problems.

SUMMARY OF THE INVENTION

A principal object of the invention is to provide a switch that reduces manufacturing cost by the absence of a special structure and that has an excellent dustproof performance by preventing dust from entering from a terminal hole.

As a means for solving the above-mentioned problems, in accordance with one aspect of the invention, there is provided a switch including a plurality of terminals fixed to a main body; a movable contact piece that is supported on the main body in a manner allowing displacement between a non-conduction position where the terminals are not connected to each other and a conduction position where the terminals are connected to each other; and a contact actuating member that is accommodated in the main body and displaces the movable contact piece from the non-conduction position to the conduction position in response to an external pressing force. The main body includes an opening that communicates with the outside, a partition wall formed between the opening and the movable contact piece, a barrier wall formed above the partition wall, and a passage formed by an end portion of the barrier wall and a wall that is opposite the end portion of the barrier wall. The partition wall extends across the passage, and the terminal includes a connection portion that is connected to a conductor which passes through the opening and a blocking portion that is bent from the connection portion and blocks the passage.

According to this aspect of the invention, since the partition wall crosses the passage, a sectional area of a route of entry of dust from the opening to the inside of the switch is minimized and the blocking portion of the terminal blocks the route of entry, resulting in excellent dustproof performance. Moreover, since the terminal needs not have a special structure, the manufacturing cost can be reduced.

In this aspect, the partition wall may include a guide groove used to spread a viscous material between the terminal and the partition wall. According to this aspect, since the viscous material is spread between the partition wall and the terminal using the guide groove, a gap between the partition wall and the terminal can be sealed. Accordingly, dust can be prevented from entering the inside of the main body. Moreover, since the viscous material is spread only between the partition wall and the terminal, the amount of the viscous material spread for dust proofing can be reduced, and therefore the manufacturing cost can also be reduced.

According to another aspect of the invention, the switch includes a cover that covers the main body, and the main body further includes a reinforcement portion that fixes the cover in between the barrier wall and the movable contact piece. A reinforcement portion-side passage is formed by the reinforcement portion and a wall that is opposite the reinforcement portion, and the blocking portion of the terminal blocks the reinforcement portion-side passage. According to this second aspect of the invention, since the blocking portion blocks the reinforcement portion-side passage, two places, i.e., the passage and the reinforcement portion-side passage, are blocked up. Therefore, dust from the opening is prevented from entering the inside, resulting in a further improvement in the dustproof performance of the switch.

According to still another aspect of the invention, the main body includes a protrusion provided between the barrier wall and the movable contact piece. The terminal has a bent portion that is bent from the blocking portion on the opposite side of the connection portion of the terminal, and the bent portion is locked to the protrusion. According to this third aspect of the invention, dust that has entered from the opening is sealed by the bent portion and the protrusion. This dust is prevented from arriving at the movable contact piece, thus further improving the dustproof performance of the switch.

For a full understanding of the present invention, reference should now be made to the following detailed description of the preferred embodiments of the invention as illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view illustrating an embodiment of a switch according to the present invention which is seen from above.

FIG. **2** is a perspective view which illustrates the switch of FIG. **1** and is seen from below.

FIG. **3** is an exploded perspective view of the switch of FIG. **2**.

FIG. **4** is an exploded perspective view of the switch seen from the opposite side of FIG. **3**.

FIG. **5** is a perspective view illustrating a main body illustrated in FIG. **3**.

FIG. **6** is a front view illustrating the switch before being operated, with a cover removed.

FIG. **7** is a front view illustrating the switch after being operated, with the cover removed.

FIG. **8**A is a perspective view of a common terminal, seen from one side, and FIG. **8**B is a perspective view of the common terminal seen from the side opposite to that shown in FIG. **8**A.

FIG. **9**A is a perspective view of a common terminal, seen from one side and FIG. **9**B is a perspective view of the common terminal seen from the side opposite to that shown in FIG. **9**A.

DETAILED DESCRIPTION

Embodiments of a switch **11** according to the present invention are described below in reference to the accompa-

nying drawings, FIGS. **1** to **9**B. Identical elements shown in the various figures are identified with the same reference numbers.

As illustrated in FIGS. **1** to **4**, the switch **11** includes: a main body **21** (see FIG. **3**) with an opening on the front side; and a cover **46** to cover the main body **21**. A switch assembly **50** to be described later is accommodated in the interior space of the main body **21**.

As illustrated in FIG. **5**, the main body **21** includes a front frame **22**, a rear frame **23**, and an upper frame **24** which is located above the front frame **22** and the rear frame **23**. A standing wall **26** is formed to extend upward from a center portion of a lower end of the main body **21**, and a first protrusion **26***a* is formed to protrude from the upper end of the standing wall **26** toward the front frame **22**. In addition, at a lower portion of the standing wall **26**, a first accommodation space **27** is provided between the standing wall **26** and the front frame **22**, and a second accommodation space **28** is provided between the standing wall **26** and the rear frame **23**.

Two conductor insertion openings **29** through which conductors are externally inserted are provided at lower ends of the first accommodation space **27** and the second accommodation space **28**, respectively. The top of the first accommodation space **27** is partitioned by a first partition wall **30***a* which extends horizontally from a middle portion of the standing wall **26** to the front frame **22**. The top of the second accommodation space **28** is partitioned by a second partition wall **30***b* which extends horizontally from a lower portion of the rear frame **23** to the standing wall **26**. Grease guide grooves **32** are formed along the side end surfaces of these partition walls **30***a* and **30***b*. Moreover, the partition walls **30***a* and **30***b* are located deep inside by a dimension L with respect to the side end surfaces of the front frame **22** and the standing wall **26** which are flush with each other. The dimension L is preferably short. Such a configuration allows a reduction in a sectional area of a route between the first accommodation space **27** and a first passage **41** to be described later, and a sectional area of a route between the second accommodation space **28** and a second passage **43** to be described later, so that dust which has entered from the insertion holes **29** is prevented from arriving at a third accommodation space **36**.

A first barrier wall **31***a* that horizontally extends from the standing wall **26** toward the front frame **22** is provided on the first partition wall **30***a*. Similarly, a second barrier wall **31***b* that horizontally extends from the standing wall **26** toward the rear frame **23** is provided on the second partition wall **30***b*. There are predetermined gaps, respectively, between a leading end of the first barrier wall **31***a* and the front frame (opposite wall) **22** which is opposite the leading end and between a leading end of the second barrier wall **31***b* and the standing wall **26** (opposite wall) which is opposite the leading end, and the gaps form the first passage **41** and the second passage **43**, respectively.

A first reinforcement portion **33***a*, which is configured in a substantially rectangular parallelepiped shape and which is formed to extend from an interior surface of the main body **21** is provided on the top of the first barrier wall **31***a*, and, similarly, a second reinforcement portion **33***b* is provided on the top of the second barrier wall **31***b*. These reinforcement portions **33***a* and **33***b*, each have a through-hole **34** that extends through the main body **21**. A second protrusion **35**, that protrudes from the rear frame **23** toward the standing wall **26**, is formed in an upper base portion of the second reinforcement portion **33***b*. Predetermined gaps are provided between the first reinforcement portion **33***a* and the front frame **22** (opposite wall) and between the second reinforcement portion **33***b* and the standing wall **26** (opposite wall). The predetermined gaps form a first reinforcement portion-side passage **42** and a second reinforcement portion-side passage **44**, respectively.

The third accommodation space **36** which is partitioned by the front frame **22**, the rear frame **23**, and the upper frame **24** and which has a larger volume than the first accommodation space **27** and the accommodation space **28** is formed above the first and second reinforcement portions **33***a* and **33***b*. The third accommodation space **36** communicates with the outside through a round hole **37** formed in an upper portion of the front frame **22**, and an operation shaft **77** of a contact actuating member **71** to be described later passes through the round hole **37**. An annular dustproof ring **38** (FIG. **3**) is arranged around the round hole **37** to seal a clearance between the round hole **37** and the operation shaft **77**. An engagement rib **39**, which extends horizontally, protrudes inward from the interior surface in the third accommodation space **36**, and a guide **72** of the contact actuating member **71** to be described later engages with the engagement rib **39**.

Further, the first accommodation space **27** communicates with the third accommodation space **36** through the first passage **41** and the first reinforcement portion-side passage **42**. Similarly, the second accommodation space **28** communicates with the third accommodation space **36** through the second passage **43** and the second reinforcement portion-side passage **44**.

As shown in FIG. **3**, the front side of the cover **46** is shaped to cover the main body **21** and the cover **46** is locked to the main body **21** with a frame-shaped gasket **48** interposed therebetween by a pair of pins **47** that are inserted through the through-holes **34** of the main body **21**. A motor splicer **49** that connects a power supply line to a motor is attached to the front surface of the cover **46**.

As illustrated in FIG. **6**, the switch assembly **50** includes a common terminal **51** and a fixed contact terminal **61** which are connected to an external circuit with a conductor such as a lead wire or a terminal which is not illustrated interposed therebetween, a movable contact piece **65** which is turnably supported on the common terminal **51** and the fixed contact terminal **61**, and the contact actuating member **71** which is accommodated in the main body **21** in a slidable manner with a return spring **70** interposed therebetween. The movable contact piece **65** turns between a non-conduction position where the common terminal **51** and the fixed contact terminal **61** are not connected to each other and a conduction position where both of them are connected to each other. The contact actuating member **71** allows a movable contact piece **65** to turn from the non-conduction position to the conduction position in response to an external pressing force applied by the user, against the resisting elastic force of the return spring **70**.

As illustrated in FIG. **8**, the common terminal **51** includes a rectangular external-side connection portion **52** to be connected with a conductor such as a lead wire or a terminal (not shown), a blocking portion **56** which is bent at a right angle with respect to the external-side connection portion **52**, and a turn support portion **58** which is bent at a right angle from an upper end of the blocking portion **56** and then extends in a horizontal direction. The blocking portion **56** includes a prop **53** extending in a vertical direction and having a width dimension L, and a plate-shaped portion **54** extending upward from the prop **53** and having a large width. The width dimension L of the prop **53** is preferably short and it is equal to a depth dimension L of each of the first and second partition walls **30***a* and **30***b*. The turn support portion **58** includes a concave portion **57** which supports the turn center of the movable contact piece **65**.

The common terminal **51** mounted in the main body **21** is connected with a conductor such as a lead wire or a terminal (not shown) passing through the conductor insertion hole **29** of the main body **21**. The external-side connection portion **52** of the common terminal **51** is accommodated in the first accommodation space **27** of the main body **21**. The lead wire is pinched between the external-side connection portion **52** and a rectangular washer **59** accommodated in the first accommodation space **27**, and it is fixed by a screw **60** (FIG. **3**). The blocking portion **56** is fitted in the first passage **41** and the first reinforcement portion-side passage **42** of the main body **21**. Moreover, the turn support portion **58** is accommodated in a lower portion of the third accommodation space **36** and is locked to the first protrusion **26***a* of the standing wall **26** (FIG. **6**).

As shown in FIG. **9**, like the common terminal **51**, the fixed contact terminal **61** includes an external-side connection portion **52**, a blocking portion **56**, and a horizontal plane portion **63** that is folded and bent from an upper portion of the blocking portion **56** at a right angle. This portion **63** extends horizontally, and is provided with a fixed contact **62** (See FIG. **3**) which is brought into contact with, or is separated from, the movable contact piece **65**.

The fixed contact terminal **61** mounted in the main body **21** is connected with a conductor such as a lead wire or a terminal (not shown) through a conductor insertion hole **29** and the external-side connection portion **52** of the fixed contact terminal **61** is accommodated in the second accommodation space **28** of the main body **21**. The lead wire is pinched between the external-side connection portion **52** and the rectangular washer **59** accommodated in the second accommodation space **28**, and it is fixed by a screw **60**. The blocking portion **56** is fitted in the second passage **43** and the second reinforcement portion-side passage **44** of the main body **21**. Moreover, the horizontal plane portion **63** is accommodated in a lower portion of the third accommodation space **36** and is locked to the second protrusion **35** of the rear frame **23**.

The movable contact piece **65** has a long-plate shape as illustrated in FIG. **3** and includes a turning portion **66** serving as the turn center between the non-conduction position and the conduction position. The turning portion **66** is formed to protrude downward in the vicinity of an end of the movable contact piece **65**. A movable contact **67** is attached to the other end of the movable contact piece **65** in such a manner that it is brought into contact with the fixed contact **62**. Moreover, a slide contact plate **68** which is substantially the same in shape as the movable contact piece **65** is attached to the top surface of the movable contact piece **65**, and the movable contact piece **65** and the contact actuating member **71** are slidably in contact with each other with the slide contact plate **68** interposed therebetween. Further, the movable contact piece **65** mounted in the main body **21** is disposed on top of the common terminal **51** and the fixed contact terminal **61** in the third accommodation space **36**. The turning portion **66** thereof engages with the concave portion **57** of the common terminal **51** so as to be turnably supported.

As illustrated in FIG. **3**, the contact actuating member **71** includes a rectangular parallelepiped guide **72** extending in the vertical direction, and a cylindrical operation shaft **77** that horizontally extends from the guide **72**. As illustrated in FIG. **4**, in the guide **72**, a hollow portion **73** with a circular cross section is formed to extend upward from the bottom surface. Moreover, a pressing portion **75** with a conical leading end protruding from the bottom surface is fitted in the hollow portion **73** with the spring **74** interposed therebetween.

The contact actuating member **71** mounted in the main body **21** is accommodated in the third accommodation space **36** so that the guide **72** engages with the engagement rib **39**. Moreover, the contact actuating member **71** is biased toward the front frame **22** by the return spring **70** installed between the rear frame **23** and the contact actuating member **71** with the operation shaft **77** passing through the round hole **37** of the main body **21** so as to protrude outside.

To assemble the switch **11** according to this embodiment, the washers **59**, each provided with a female thread, are initially placed inside the first and second accommodation spaces **27** and **28**. Then, the external-side connection portion **52** of the common terminal **51** is fitted in the first accommodation space **27**, and the plate-shaped portion **54** is fitted in each of the first passage **41** and the first reinforcement portion-side passage **42**. At this time, since the prop **53** of the common terminal **51** is locked to the edge of the first partition wall **30***a* and the plate-shaped portion **54** blocks up the first passage **41**, entry of dust from the conductor insertion hole **29** is prevented and, as a result, sufficient dustproof performance is maintained. Moreover, since the plate-shaped portion **54** blocks the first reinforcement portion-side passage **42**, entry of dust is prevented at two places: that is, at the first passage **41** and the first reinforcement portion-side passage **42**. Accordingly, the dustproof performance is further improved. In addition, the leading end of the turn support portion **58** located at the bottom of the third accommodation space **36** is fitted against the first protrusion **26***a*. As a result, dust that has entered from the conductor insertion hole **29** is blocked by the turn support portion **58** and the first protrusion **26***a*, so that dust is prevented from arriving at the movable contact piece **65**. In this way, the dustproof performance is further improved.

In the fixed contact terminal **61**, like the common terminal **51**, the external-side connection portion **52** is fitted in the second accommodation space **28**, and the plate-shaped portion **54** is fitted in the second passage **43** and the second reinforcement portion-side passage **44**. With this configuration, the leading end of the horizontal plane portion **63** located in a lower portion of the third accommodation space **36** is fitted against the second protrusion **35**.

Next, the movable contact piece **65** is installed above the common terminal **51** and the fixed contact terminal **61** in the third accommodation space **36** so that the turning portion **66** of the movable contact piece **65** can engage with the concave portion **57** of the common terminal **51**. The guide **72** is then also installed between the movable contact piece **65** and the upper frame **24** and the operation shaft **77** is driven through the round hole **37** to protrude outside so that the pressing portion **75** of the guide **72** pushes an end of the movable contact piece **65** with the slide contact plate **68** interposed therebetween. Thereafter, the return spring **70** is installed between the guide **72** and the rear frame **23** so that the guide **72** can be biased toward the front frame **22** by the spring force of the return spring **70**.

In addition, grease as a viscous material is spread between the side end surface of the first partition wall **30***a* and the common terminal **51** and between the side end surface of the second partition wall **30***b* and the fixed contact terminal **61** through the guide groove **32**. As a result, the gap between the first barrier wall **31***a* and the common terminal **51** and the gap between the second barrier wall **31***b* and the fixed contact terminal **61** can be more securely sealed, and thus the dustproof performance is improved. Moreover, since the grease is spread only between the side end surface of the first partition wall **30***a* and the common terminal **51** and between the side end surface of the second partition wall **30***b* and the fixed contact terminal **61**, the amount of the grease that is spread can be suppressed. Accordingly, the manufacturing cost can be reduced, and deterioration of the dustproof performance due to deterioration of the grease with time can be prevented. Moreover, the grease may be further spread between the first reinforcement portion **33***a* and the common terminal **51** and between the second reinforcement portion **33***b* and the fixed

contact terminal **61**. As a result, the first reinforcement portion-side passage **42** and the second reinforcement portion-side passage **44** can be sealed, so that a dustproof performance is further improved.

Next, the cover **46** is locked to the main body **21** by the pin **47** with the frame gasket **48** interposed therebetween, the pin **47** being inserted in the through-hole **34** of the main body **21**. The motor splicer **49** is then mounted on the front surface of the cover **46**. Conductors such as lead wires or terminals are inserted between the external-side connection portions **52** of the common terminal **51** and the fixed contact terminal **61** and the washer **59**, and, the screw **60** is tightened to make the connection.

The operation of the switch **11** which is assembled in accordance with the above-mentioned procedure will now be described. Starting from the initial state in which the user is not pushing the operation shaft **77**, the operation shaft **77** fully projects from the main body **21** to its maximum by the return spring **70**. Moreover, since the guide **72** is brought into contact with the front frame **22** and the pressing portion **75** pushes the edge of the slide contact plate **68** on the side of the turning portion **66**, the movable contact **67** and the fixed contact **62** are separated from each other and the non-contact state is maintained.

When the user pushes the operation shaft **77** inward, as shown in FIG. **7** the guide **72** slides while being in contact with the upper frame **24** and the engagement rib **39**, and moves toward the rear frame **23**, against the resistance of the return spring **70**. As a result, the pressing portion **75** pushes the substantial center of the slide contact plate **68**, and thus the movable contact piece **65** turns about the turning portion **66** from the non-conduction position to the conduction position where the movable contact **67** and the fixed contact **62** are in contact with each other. The common terminal **51** and the fixed contact terminal **61** are then connected to each other, and thus the electrical energy to the motor is turned on.

When the user releases the pressing force applied to the operation shaft **77**, the guide **72** is pressed by the spring force of the return spring **70** and is then moved toward the front frame **22** while remaining in contact with and sliding on the upper frame **24** and the engagement rib **39**. Then, the pressing portion **75** pushes down on the edge of the sliding contact plate **68** on the other side of the turning portion **66**. The movable contact piece **65** is thus kept at the non-conduction position in a state in which the guide **72** is stopped by being brought into contact with the front frame **22**.

Experimental Comparison

The present applicants performed comparison experiments to compare the dustproof performance of the switch **11** according to the present invention with conventional switches.

In the experiment, grease was spread between the common terminal **51** and the guide groove **32** of the first partition wall **30***a* and between the fixed contact terminal **61** and the guide groove **32** of the second partition wall **30***b* as in the switch **11** illustrated in FIG. **6**.

On the other hand, grease was spread in a comparative switch on the entire side end surface of the wall portion surrounding the space corresponding to the first accommodation space and the second accommodation space. The amount of the grease spread in the comparative example was about ten times that of the present embodiment.

As experimental conditions, the switches were turned on and off 1000 times in a sealed atmosphere filled with a concrete powder of 150 micrometers. At the conclusion of the experiment the switches were opened and it was confirmed that dust did not enter the inside thereof in both the present embodiment and in the comparative example.

Therefore, with the switch according to the present invention, the equal dustproof performance to the comparative example was confirmed even though the amount of grease was reduced to 1/10 times that of the comparative example.

There has thus been shown and described a novel switch which fulfills all the objects and advantages sought therefor. Many changes, modifications, variations and other uses and applications of the subject invention will, however, become apparent to those skilled in the art after considering this specification and the accompanying drawings which disclose the preferred embodiments thereof. All such changes, modifications, variations and other uses and applications which do not depart from the spirit and scope of the invention are deemed to be covered by the invention, which is to be limited only by the claims which follow.

What is claimed is:

1. A switch comprising:

a main body;

a plurality of terminals fixed to the main body;

a movable contact piece that is supported on the main body in a manner allowing displacement between a non-conduction position where each of the plurality of terminals are not connected to each other and a conduction position where each of the plurality of terminals are connected to each other; and

a contact actuating member that is accommodated in the main body and displaces the movable contact piece from the non-conduction position to the conduction position in response to an external pressing force, wherein

the main body includes an opening that coma communicates with the outside, a partition wall formed between the opening and the movable contact piece, a barrier wall formed above the partition wall, and a passage formed by an end portion of the barrier wall and an opposite wall that is opposite the end portion of the barrier wall,

the partition wall crosses the passage to sectionally block the passage, and

each of the plurality of terminals includes a connection portion and a blocking portion that bent from the connection portion and blocks the passage.

2. The switch according to claim **1**, wherein the partition wall has a guide groove used to spread a viscous material between the partition wall and a corresponding terminal of the plurality of terminals.

3. The switch according to claim **1**, further comprising:

a cover that covers the main body, wherein

the main body further includes a reinforcement portion that fixes the cover in between the barrier wall and the movable contact piece, and a reinforcement portion-side passage formed by the reinforcement portion and a wall that is opposite the reinforcement portion, and

the blocking portion of the corresponding terminal of the plurality of terminals blocks the reinforcement portion-side passage.

4. The switch according to claim **1**, wherein

the main body includes a protrusion provided between the barrier wall and the movable contact piece, wherein

each of the plurality of terminals has a bent portion that is bent from the blocking portion on the opposite side of the connection portion of each of the plurality of terminals, and

the bent portion is locked to the protrusion.

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